



Figure 1. Vicinity Map of the U.S. Army Engineer District, Portland. Project location for mouth of the Columbia River (Benson Beach) is shown in top left corner.

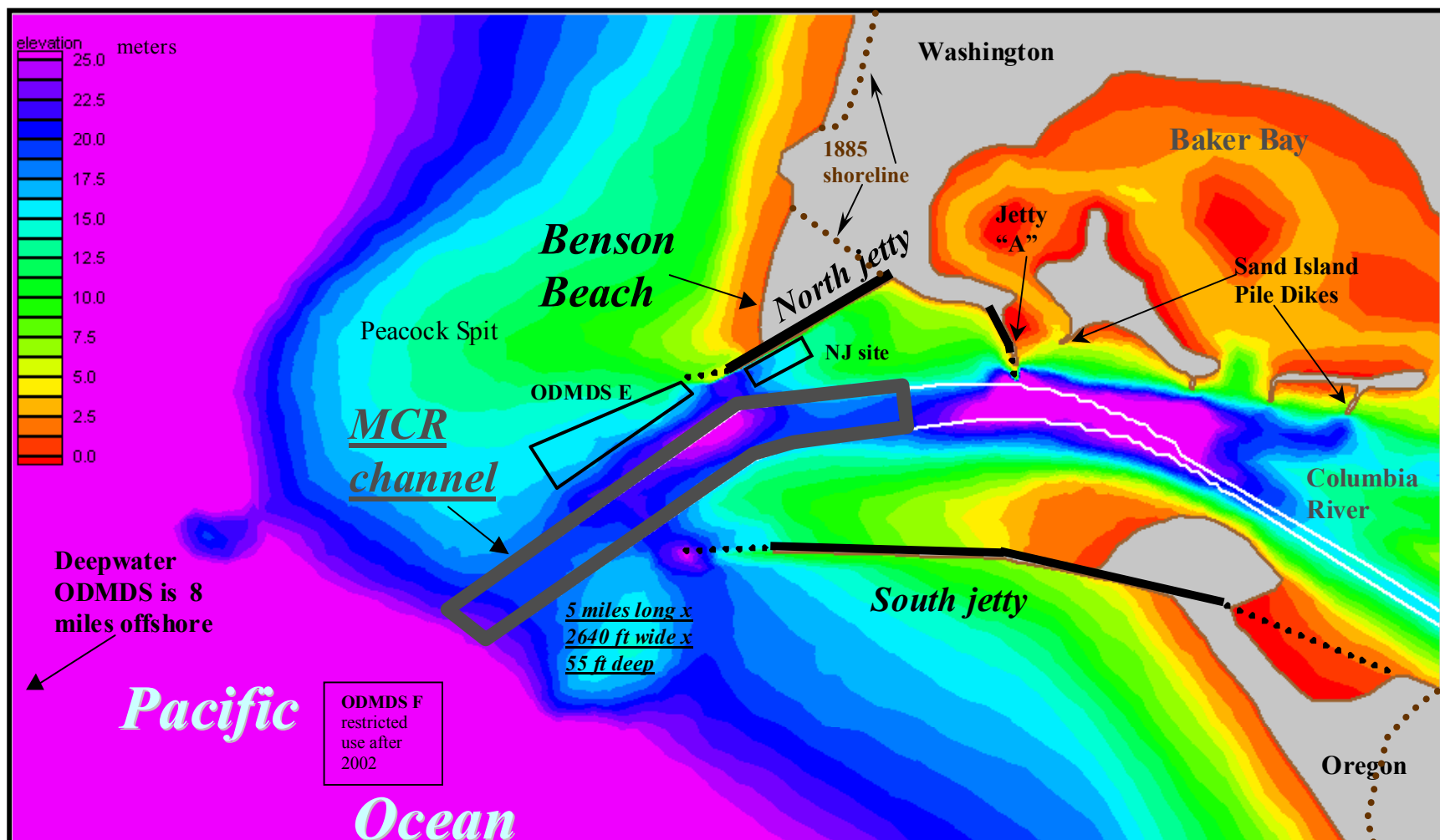


Figure 2. Navigation Features at the Mouth of the Columbia River, WA & OR. Benson Beach is located on the north side of the north jetty. Ocean dredged material disposal sites (ODMDS) shown for 2003. Note the pre-jetty (1885) shoreline shown as dotted brown line.

2 miles

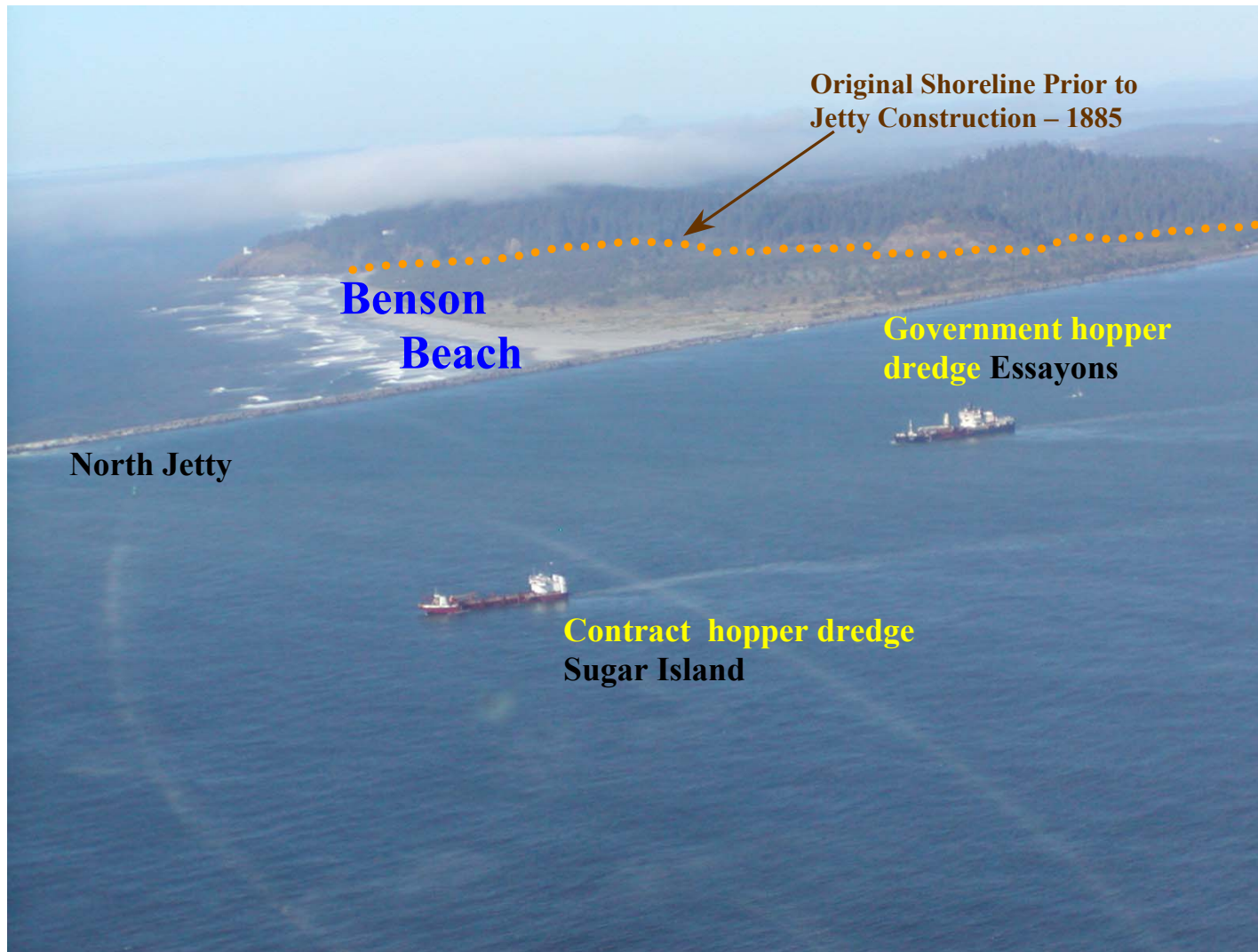


Figure 3. Hopper dredges working at the mouth of the Columbia River bar, Sept 2002.

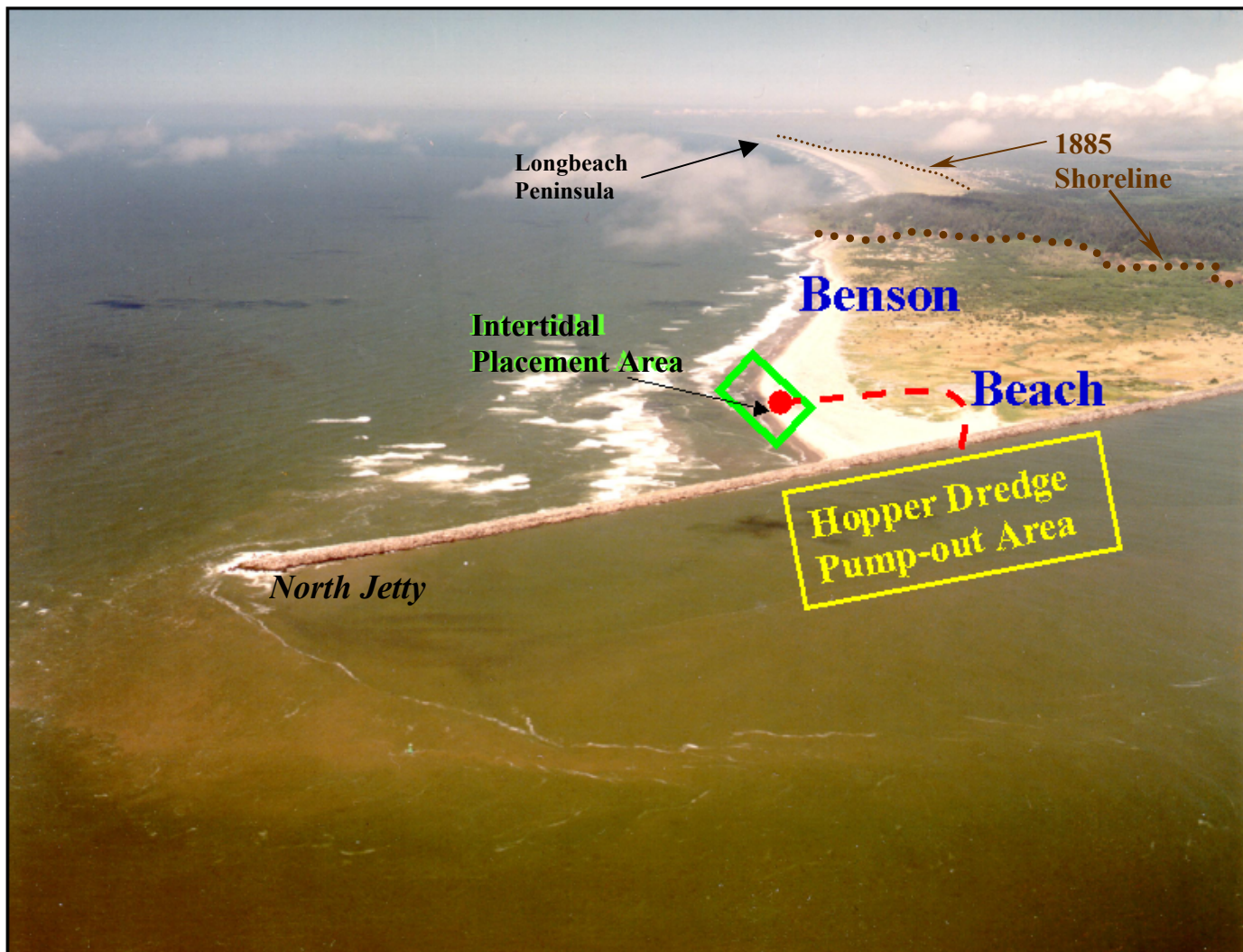


Figure 4. Location of Benson Beach, hopper dredge pump-out and inter-tidal placement areas for 2002 Benson Beach pilot study.



Figure 5. Pump-out operation of a hopper dredge (1 load) during Benson beach pilot project: 19 loads were placed during 16-19 July 2002 (44,000 cy). Overall pump-out time averaged 1.5 hour/load.

**Dredging + Disposal Cycle Time at MCR for Hopper Dredge *Sugar Island* during 16-19 July 2002
"Open Water at Site E" vs. "Pump-Ashore at Benson Beach"**

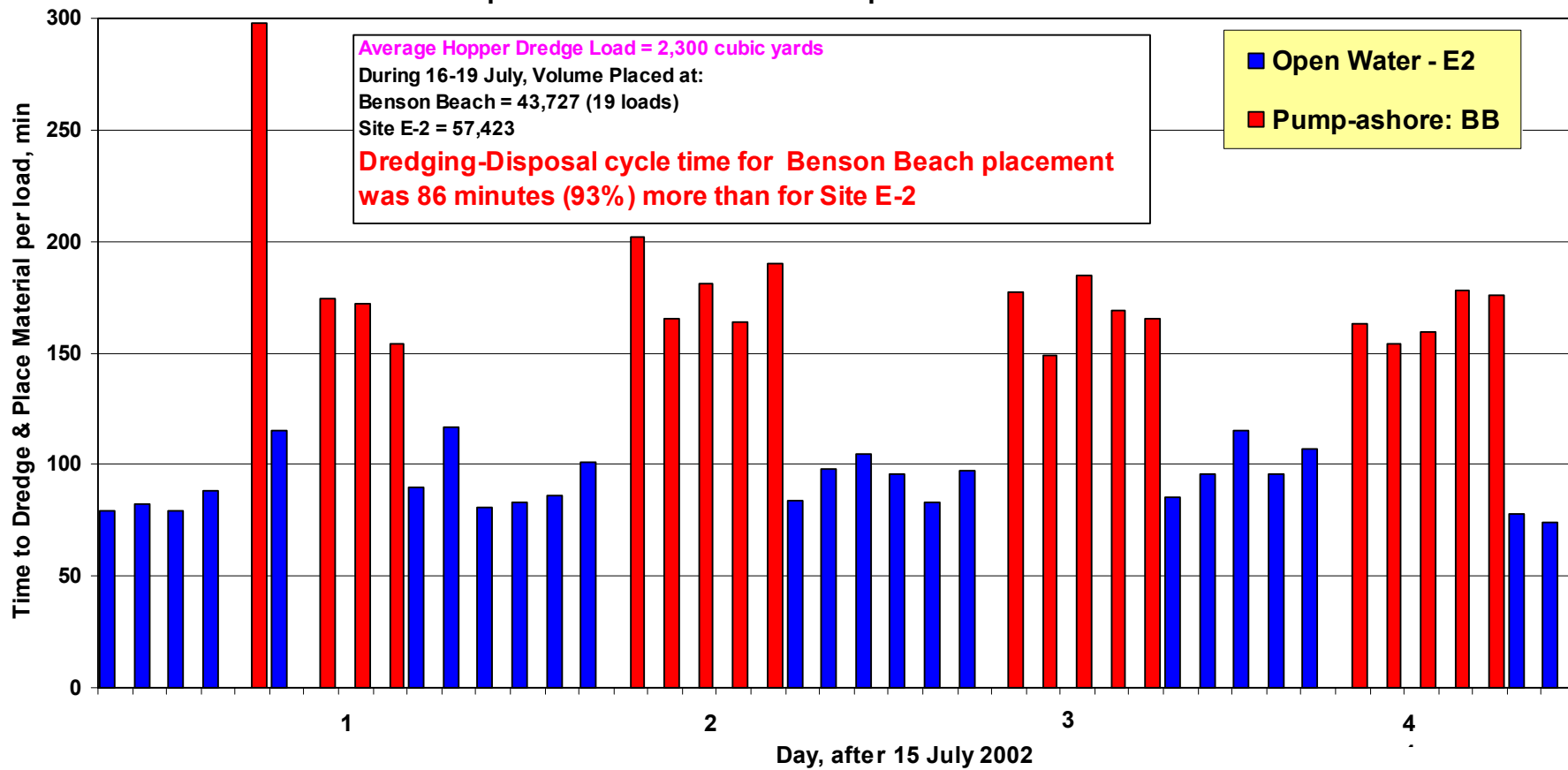


Figure 6. Production time for contract hopper placing dredged sand at principal open water dredged material disposal site (ODMDS) E vs. placing dredged material on Benson Beach.

Oceanographic Conditions During Benson Beach Sand Placement

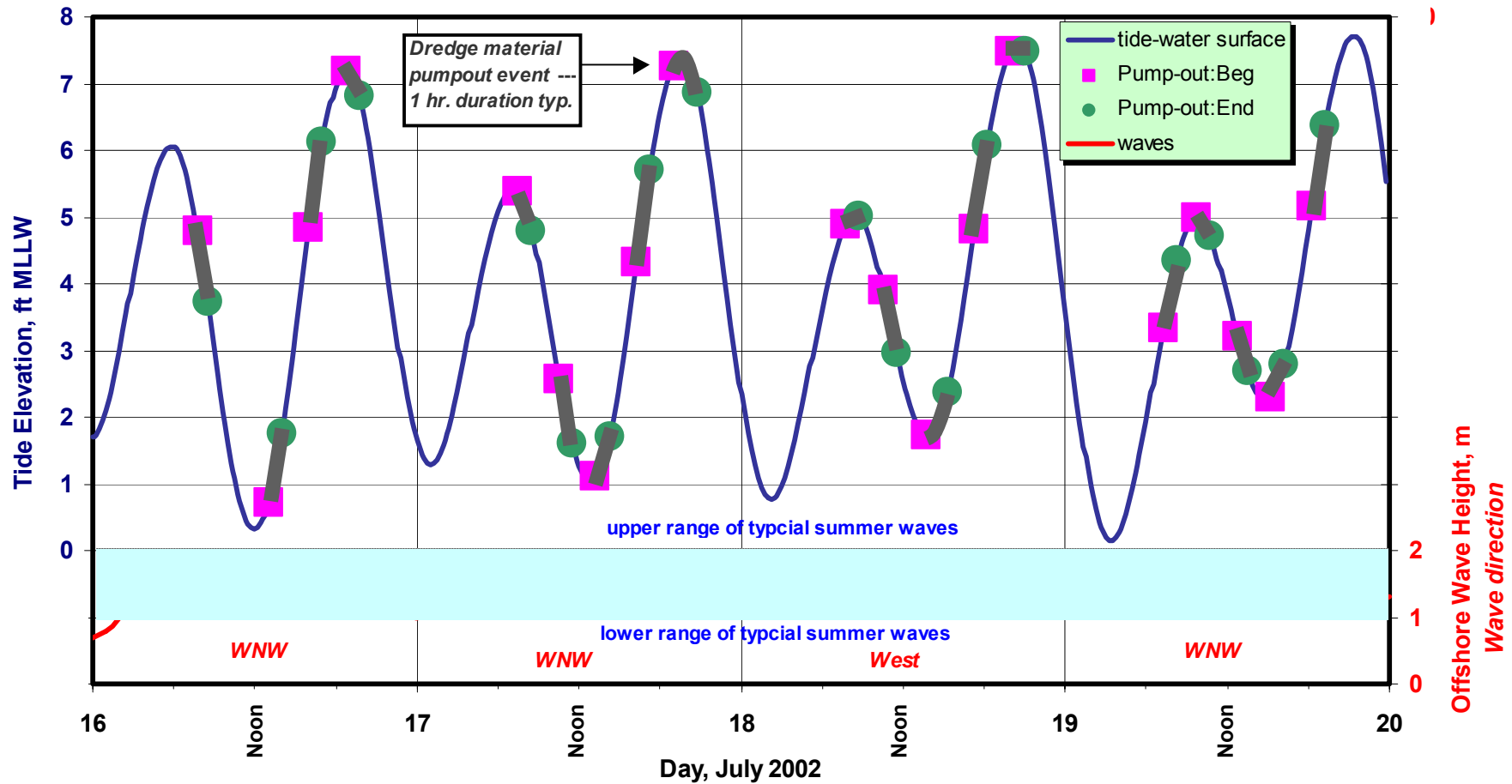


Figure 7. Tidal and wave conditions during Benson Beach placement operations. Note that placement occurred only during daylight hours and that placement occurred during all phases of the tide (high, low and mid). Wave conditions were calmer than normal.

Daily Production Rate for the Hopper Dredge Sugar Island at MCR for Various Disposal Site Scenarios

note: maximum days available in dredging season at MCR bar = 120, maximum days available for contract hopper dredge = 60

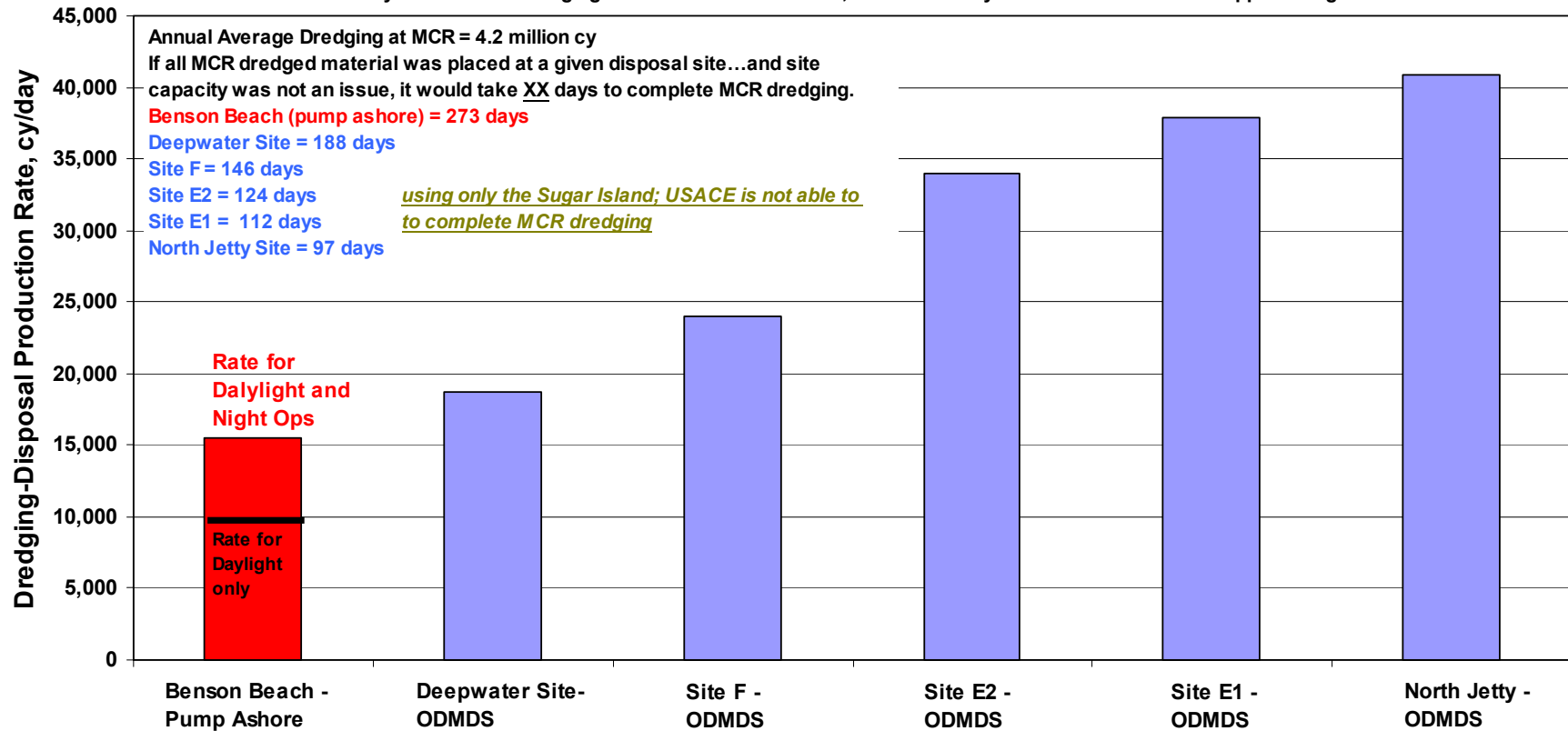
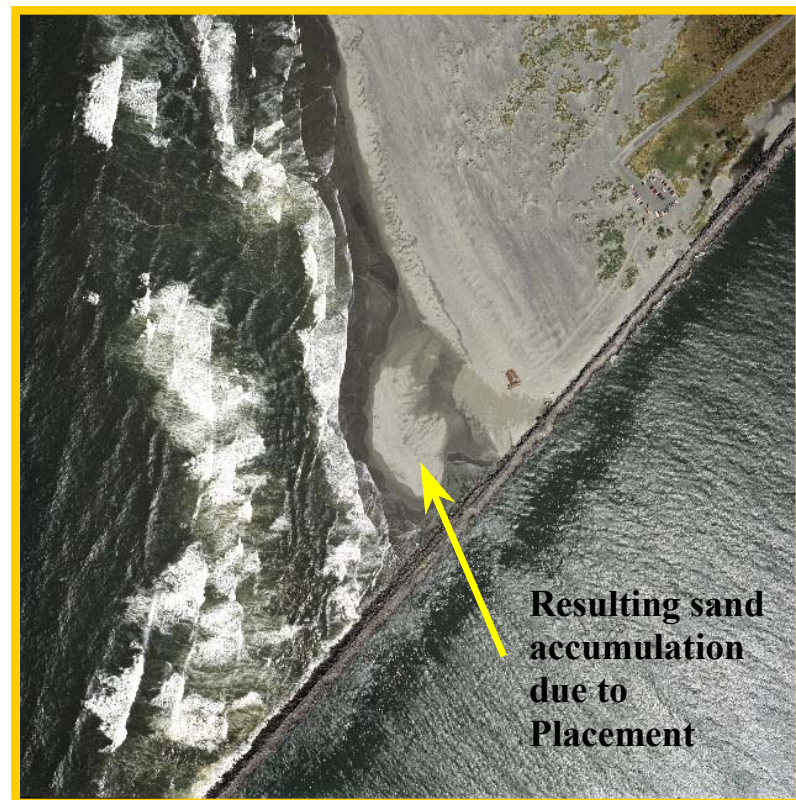


Figure 8. Comparison of contract hopper dredge production rates for various MCR disposal sites. Note that ODMDS F will not be used after 2002. The contract hopper dredge would require $\frac{3}{4}$'s of a year to place all the MCR annual maintenance dredging at Benson Beach-pump ashore site.



Before Sand Placement on
Benson Beach – 9 July 2002



After Sand Placement on
Benson beach – 21 July 2002

Figure 9. Comparison of aerial photographs of Benson Beach “before” and “after” placement (16-19 July). Approximately 44,000 cy was placed. Tide and scale in the photos are similar. The area of sand accumulation shown in the photo at right is about 600 ft N-S and 500 ft W-E.

Photos courtesy of PI Engineering, LLC.

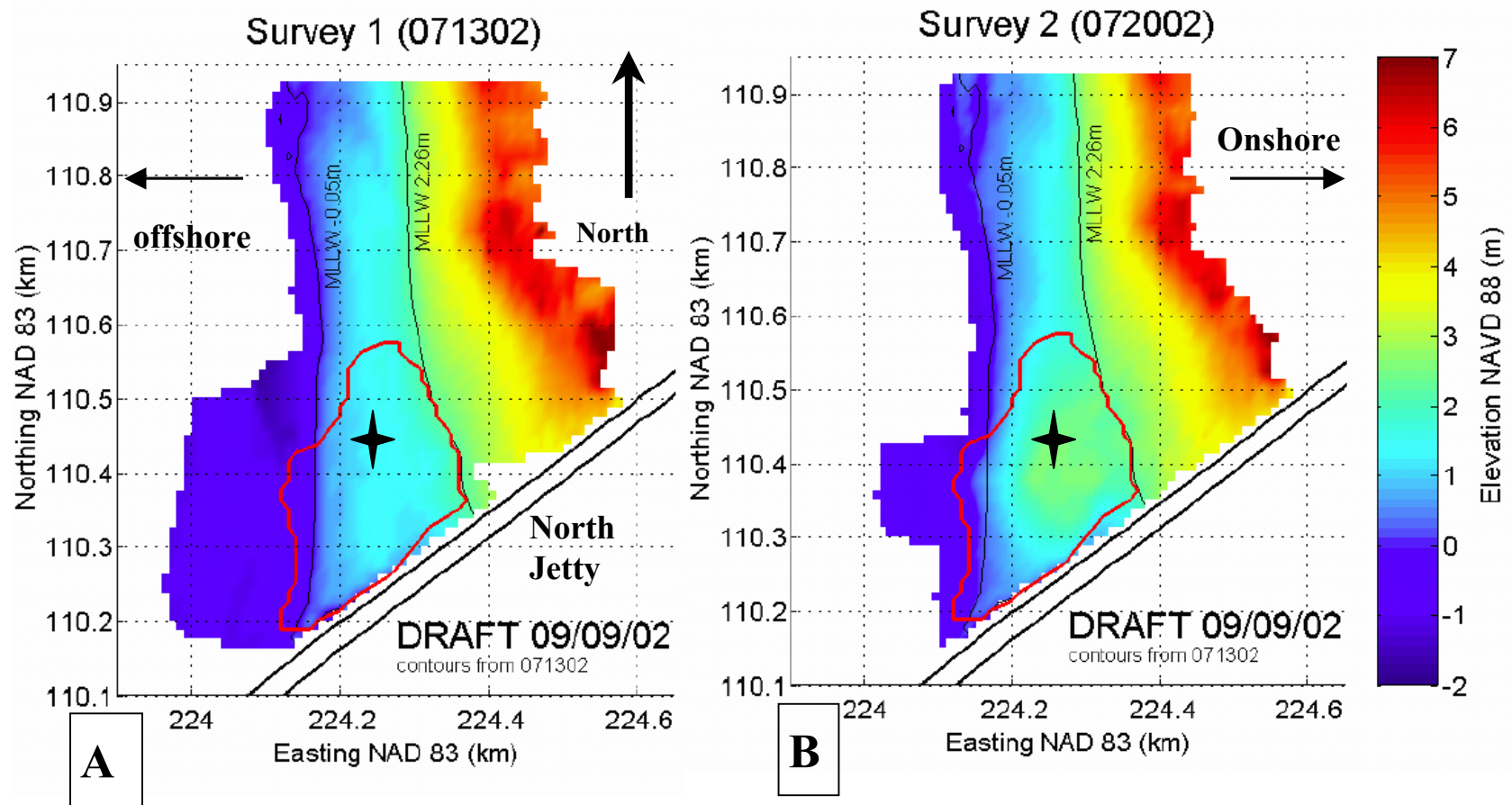


Figure 10. First of 10 topographic surveys obtained at Benson Beach during monitoring activities to date: during monitoring actions to date. (A) is 13 July and (B) is 20 July. Sand placement on Benson Beach occurred 16-19 July. Red polygon demarcates area where placed sand has accumulated; black cross is average location where dredged sand was placed on BB. Shore area within two black contour lines is the inter-tidal zone of Benson Beach. Data and figure, WDOE & USGS

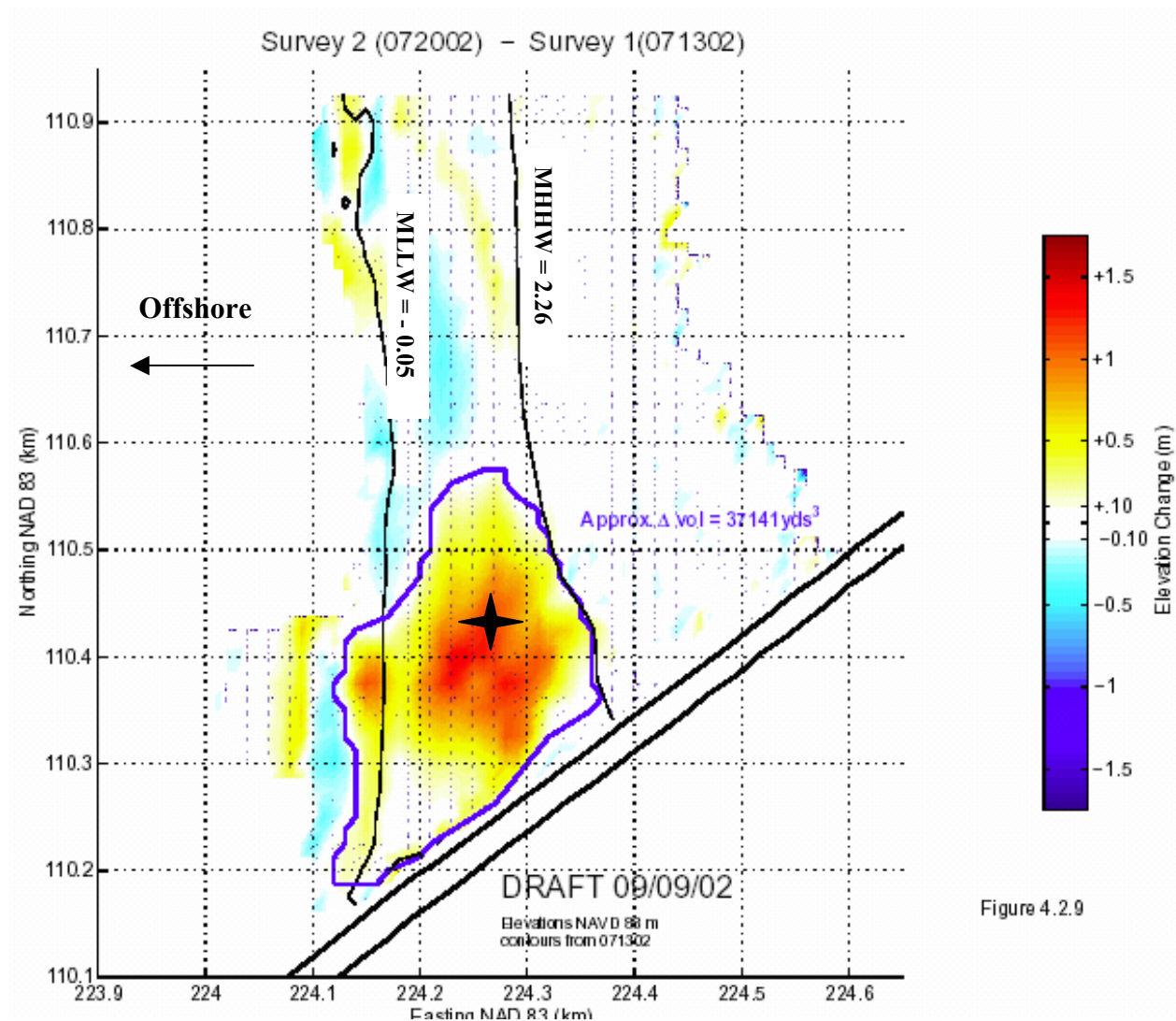


Figure 11. Observed topographic change that occurred between the surveys shown in figure 10. Deposition = yellow-red, Erosion = blue. Blue polygon inscribes area where placed dredged material has accumulated. Volume of accumulation in polygon = 37,000 cy (86% of what was placed on beach 16-19 July). The dredged sand that was placed on the beach did not disperse far from where it was discharged. The black cross is where sand was placed. Data and figure, WDOE & USGS

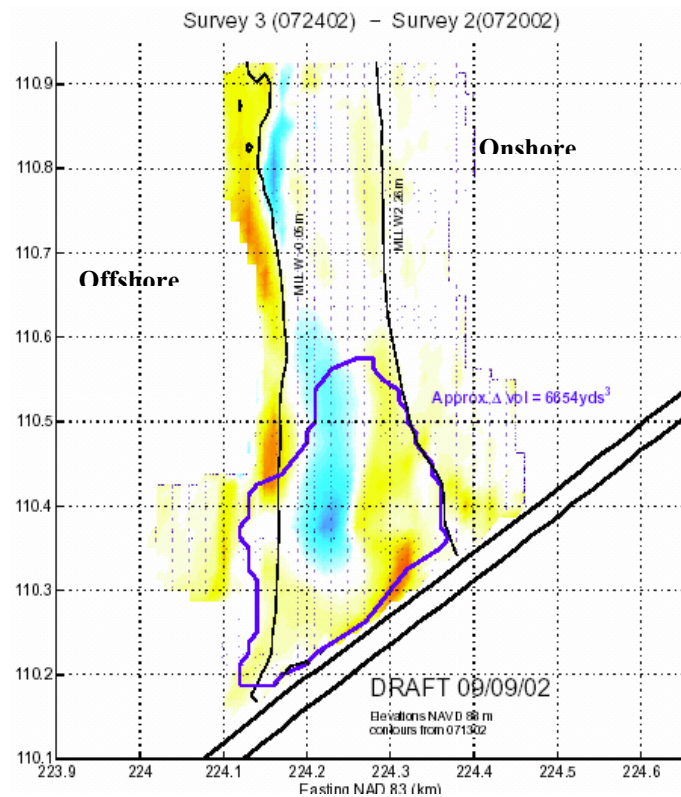


Figure 4.2.10

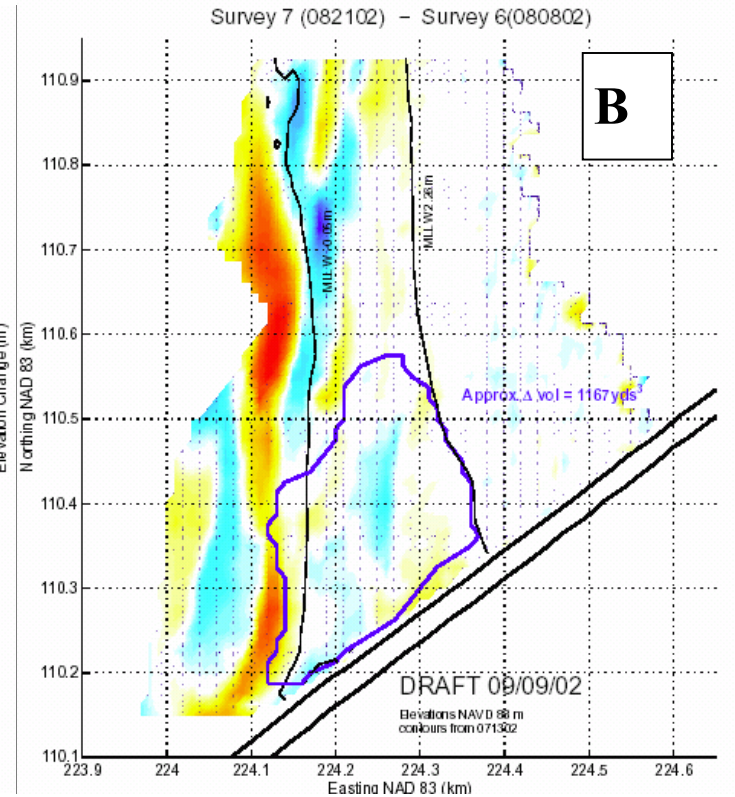


Figure 12. Observed topographic change for (A) 20 July – 24 July and for (B) 8 Aug – 21 Aug. In (A), the placed dredged sand is reworked by waves/currents slightly such that the sand moves onshore & toward the north jetty. In (B), large sand bars appear to be moving onshore & more of the sand within the blue polygon is moved toward the north jetty. Data and figure, WDOE & USGS

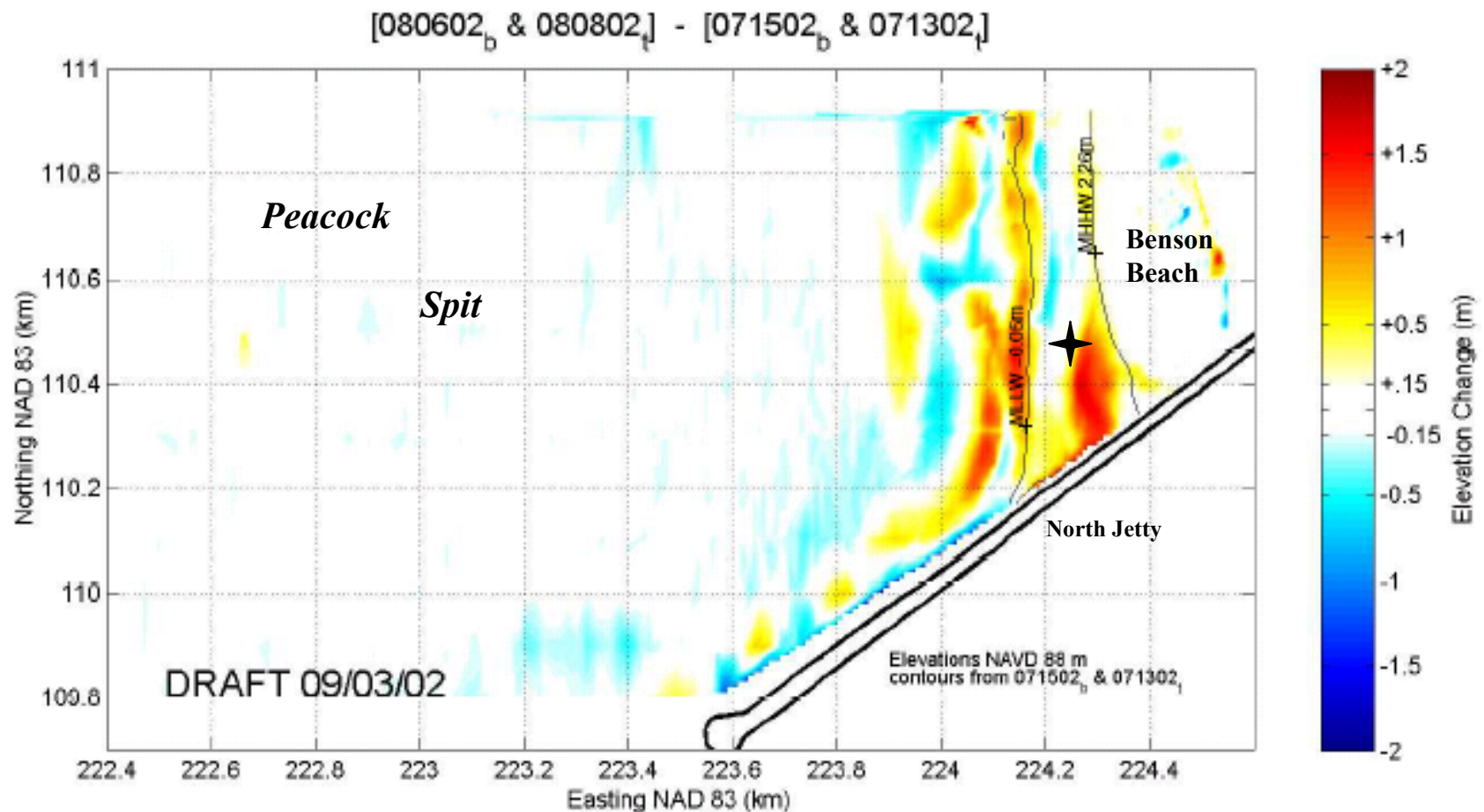


Figure 13. Observed topographic/seabed change that occurred at Benson Beach and Peacock Spit during 15 July & 8 Aug 2002. Note the narrowing of the sand accumulation area associated with the dredged sand placement operation and formation of large offshore sand bars below the MLLW line. The volume of sand contained in the offshore sand bars is +> than the volume in the Benson Beach “fill” area. Note that the placed dredged material and the offshore sand bars are moving offshore along the north jetty. The black cross shows the average location where the dredged sand was placed on Benson Beach. Data and figure, WDOE & USGS

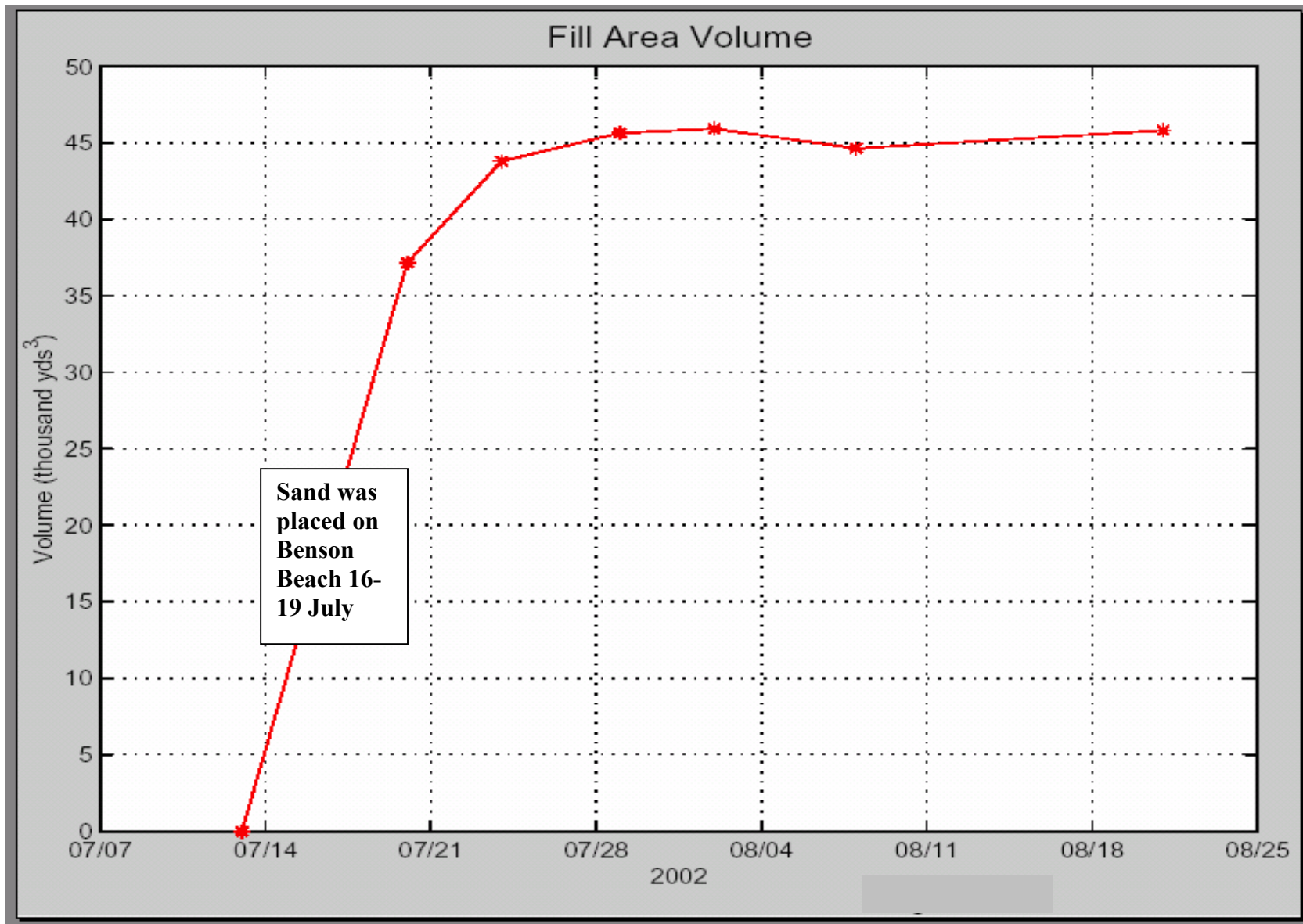


Figure 14 . Rate of volume change for the mound of sand which formed in response to dredged material placed on Benson Beach (blue polygon on figs 10-12). Dots indicate survey dates. Note that mound volume did not change for 1 month after placement. Data and figure, WDOE & USGS.

MCR Dredging-Disposal Progress Timeline for Various "Site E" Strategies

4.2 Mcy to dredge, contract dredge: 1.5 Mcy, and gov't dredge: 2.7M.

Use of "Deepwater Site" and NO Dredged Material Placed on Benson Beach

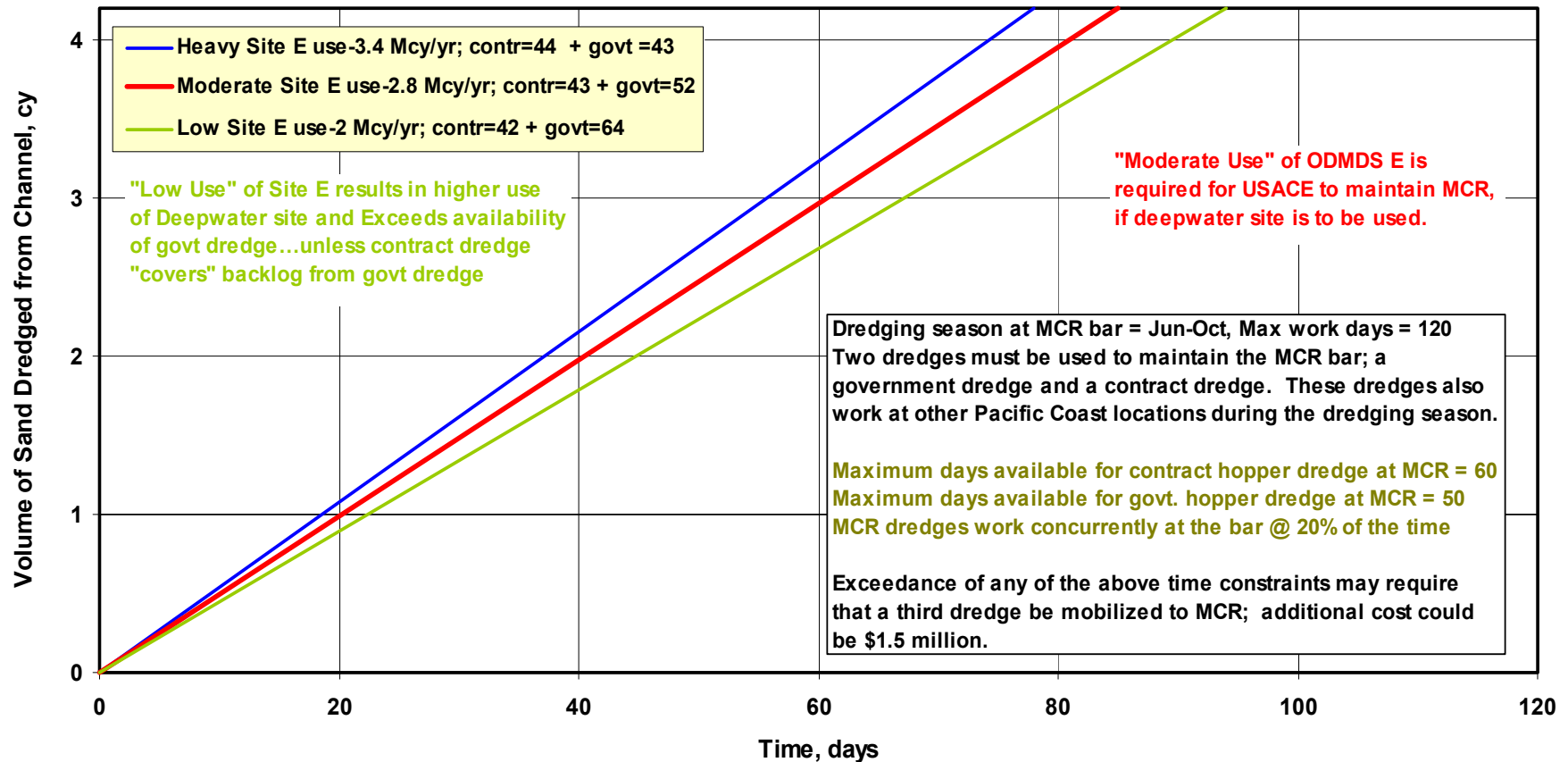


Figure 15. The efficiency of dredging & disposal at MCR is governed by the degree to which ODMDS E is used. Reliance on ODMDS E will be essential when the Deepwater ODMDS is used (2003 and later). Results are based on optimizing the use of ODMDS E and the North Jetty Site and minimizing use of the Deepwater ODMDS. Use of Benson Beach is not included.

MCR Dredging-Disposal Production for Various "Benson Beach" Strategies

4.2 Mcy to dredge, contract dredge: 1.5 Mcy, and gov't dredge: 2.7Mcy.

Assumes use of "Deepwater Site" and moderate use of "Site E", WITH Dredged Material Placed on Benson Beach

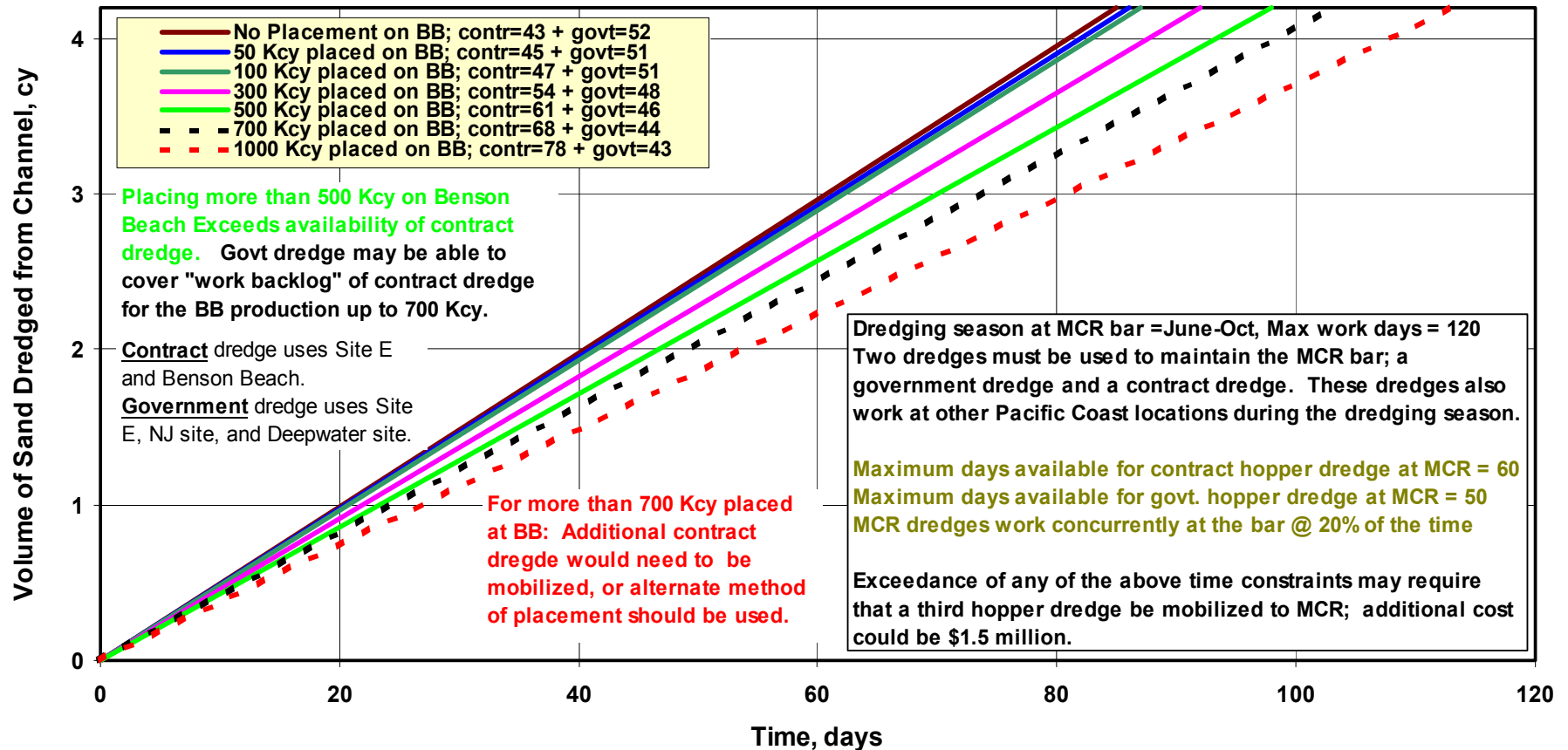


Figure 16. Time-duration determination for the maximum volume of dredged sand that can be placed at Benson Beach using a hopper dredge for pump-ashore option. Results are based on the optimization of using ODMDS E (maximize), North Jetty Site (maximize), Deepwater ODMDS (minimize), and Benson Beach (maximize). Note that the maximum that can be placed at Benson Beach and still use 2 dredges at MCR is 700,000 cy/yr.

Unit Cost of MCR Dredging/Disposal: Contract Dredge Cost for Placement at *ODMDS E* vs. Incremental Cost for Placement at *Benson Beach* or *Deepwater ODMDS*

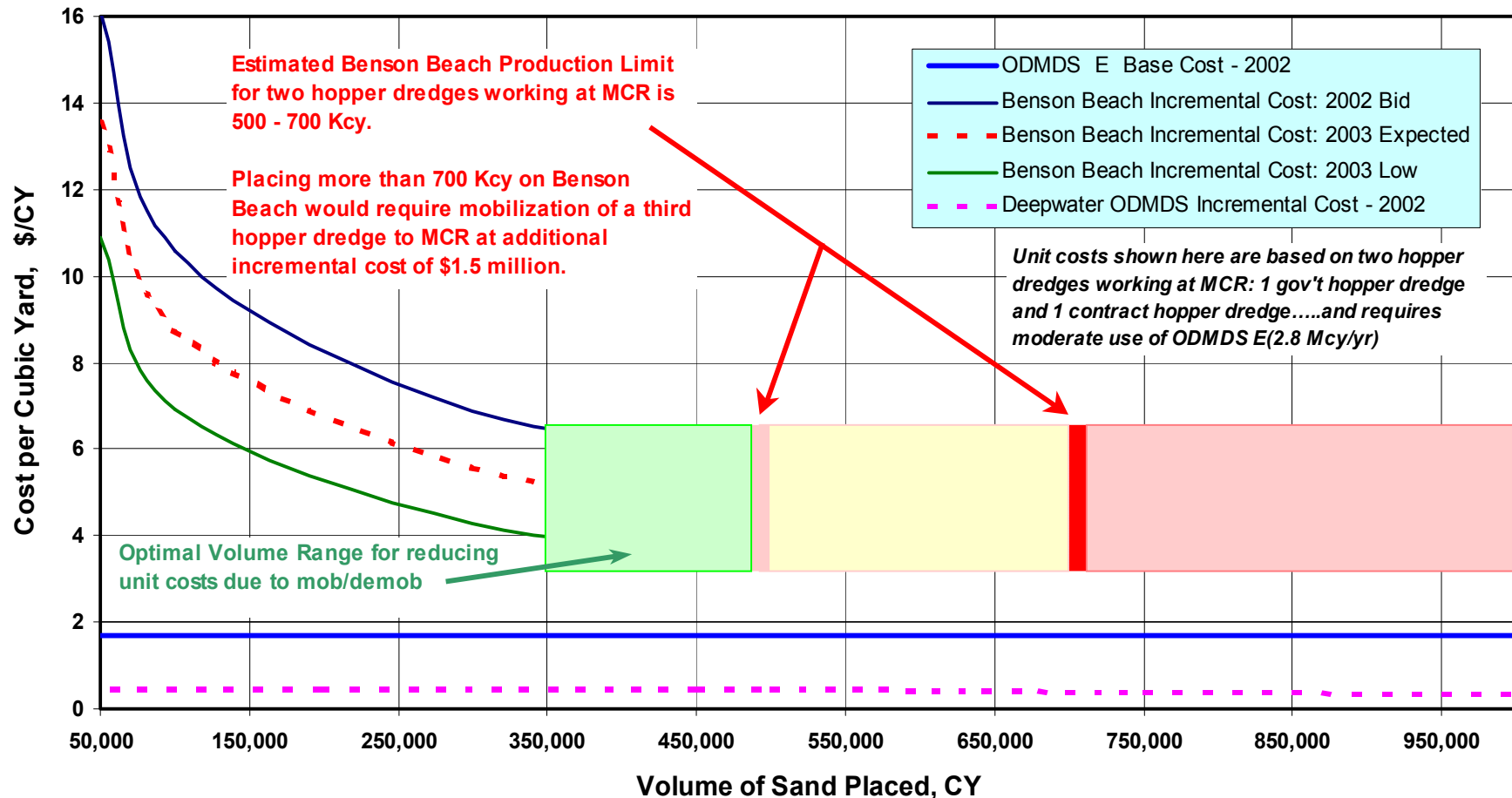


Figure 17. Calculation for the incremental unit cost (\$/cy) of placing dredged sand on Benson Beach as a function of volume placed, in terms of base cost for using ODMDS E . Benson Beach production limit is based on optimized values from figure 16. The dashed red curve reflects the decreased cost of Benson Beach placement based on the reduced risk associated with “learning” from 2002 operations. Note base unit cost of placing dredged sand at ODMDS E and incremental unit cost of using the Deepwater ODMDS. To cast incremental cost of Benson Beach in terms of Deepwater ODMDS, subtract \$0.46 from BB unit cost.

Incremental Cost for Contract Hopper Dredge to Place MCR Dredged Material on Benson Beach

2002 Base cost for contract dredge to place 1.5 Mcy at ODMDS E is \$2.6 M
contract hopper dredge capacity = 2,300 cy, govt and contract dredges are working at MCR

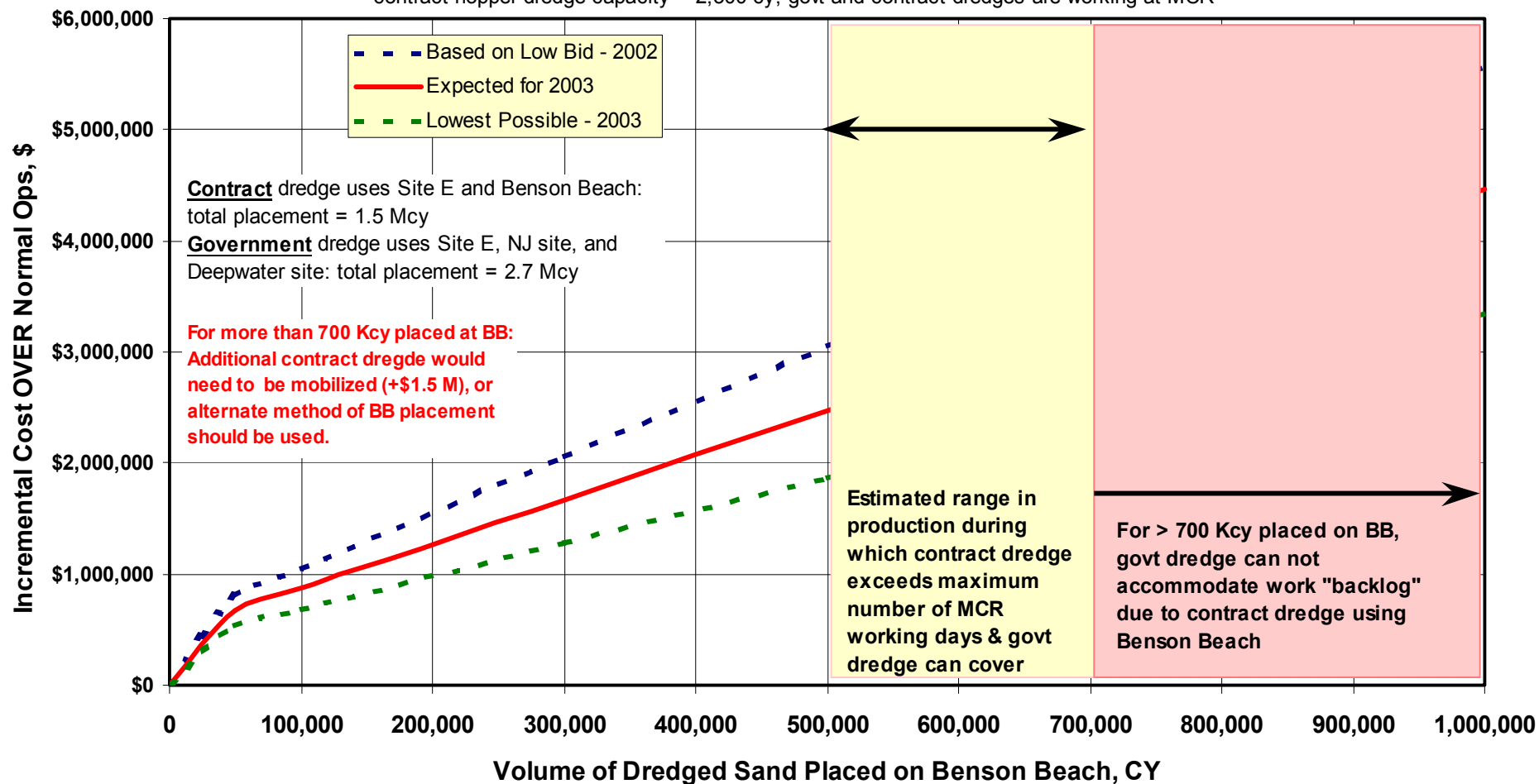


Figure 18. Calculation of incremental cost for using Benson Beach disposal alternative as compared to “normal” operation of contract hopper dredge using ODMDS E. Note limits of volume that can be placed on Benson Beach and still accomplish MCR O&M dredging using 2 dredges. Results are based on previous figures.